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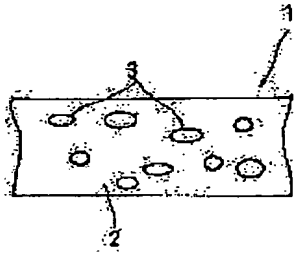
(71)Applicant : READ RITE S M I KK
(72)Inventor : SUZUKI KOICHI
KOMAKI KENJI

(54) MAGNETIC THIN FILM AND METHOD THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a magnetic thin film which is mainly used as a magnetic body of a thin-film magnetic head suitable for a high density magnetic record, is manufactured by a plating method, is high in saturated magnetic flux density, is excellent in soft magnetic characteristics and has high resistivity, and a method for manufacturing the magnetic thin film.
SOLUTION: A toning bath for electrically plating a processing substance and forming a magnetic thin film on a surface of the processing substance contains Fe2+ ions, Ni2+ ions and Co2+ ions, and also fine particles of SiO2 or Al2O3 are scattered in a colloid form. In a manufactured thin film of a magnetic alloy, silica or alumina 3 is scattered in a Co-Ni-Fe ternary alloy 2 (a magnetic body) with high resistivity.



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(71)出願人　392034355
リードライト・エスエムアイ株式会社
大阪府三島郡島本町江川２丁目15番17号

(72)発明者　鈴木　功一
大阪府大阪市中央区北浜４丁目５番33号
住友金属工業株式会社内

(72)発明者　小巻　賢治
大阪府三島郡島本町江川２丁目15番17号
リードライト・エスエムアイ株式会社内

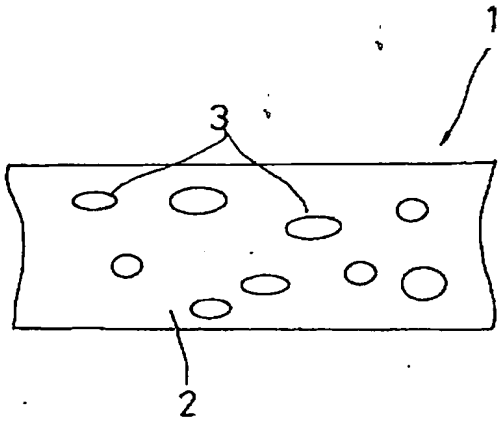
(74)代理人　弁理士　藤田　隆

(54)【発明の名称】　磁性薄膜および磁性薄膜の製造方法

(57)【要約】

【課題】　高密度磁気記録に適した薄膜磁気ヘッドの磁性体として主に用いられる磁性薄膜であり、めっき法により製造され、飽和磁束密度が高く、軟磁気特性に優れ、かつ高比抵抗を有する、磁性薄膜および磁性薄膜の製造方法を提供する

【解決手段】　処理物を電気めっきし、処理物の表面に磁性薄膜を形成させるめっき浴は、Fe^{2+}イオン、Ni^{2+}イオン及びCo^{2+}イオンを含み、且つSiO_2又はAl_2O_3の微粒子がコロイド状に分散されている。製造された、磁性合金の薄膜中には、Ｃｏ－Ｎｉ－Ｆｅ３元系合金２（磁性体）内に、シリカまたはアルミナ３が分散されており、比抵抗が高い。



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CLAIMS

[Claim(s)]
[Claim 1]In a manufacturing method of a magnetic thin film which electroplates a treatment object and makes a magnetic thin film form on the surface of a treatment object during a plating bath, a plating bath, A manufacturing method of a magnetic thin film, wherein it contains two or more sorts of ion chosen from Fe^{2+} ion, $nickel^{2+}$ ion, and Co^{2+} ion and particles of an insulator are distributed during a plating bath.

[Claim 2]Two or more sorts of ion chosen from said Fe^{2+} ion, $nickel^{2+}$ ion, and Co^{2+} ion, A manufacturing method of the magnetic thin film according to claim 1 which is supplied by sulfate and/or hydrochloride and is characterized by a plating bath's being an acidic bath and particles of an insulator distributed during a plating bath being colloidal particles of SiO_2 and/or $aluminum_2O_3$.

[Claim 3]A magnetic thin film which was manufactured by a manufacturing method of the magnetic thin film according to claim 1 or 2 and in which particles of an insulator were distributed in a thin film of a magnetic alloy.

[Claim 4]A magnetic thin film, wherein SiO_2 and/or $aluminum_2O_3$ is distributed in a thin film of a Fe-Ni-Co alloy.

[Claim 5]In a manufacturing method of a thin film magnetic head which forms on a substrate two or more magnetic thin films and a conductor coil film which intervenes between these magnetic thin films, and constitutes a magnetic circuit with a magnetic thin film and a conductor coil film, A manufacturing method of a thin film magnetic head, wherein much more magnetic thin film at least is formed by a manufacturing method of the magnetic thin film according to claim 1 or 2.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the manufacturing method of a magnetic thin film and a magnetic thin film. The magnetic thin film of this invention is used as the magnetic body of a thin film magnetic head suitable for high-density magnetic recording, and magnetic shielding, its saturation magnetic flux density is high, and it is excellent in soft magnetic characteristics, and has high specific resistance. This invention relates to the manufacturing method of a thin film magnetic head collectively.
[0002]
[Description of the Prior Art]In recent years, the thin film by plating is broadly used for electronic parts etc. as a functionality thin film provided not only with the object for an ornament, or the object for corrosion prevention but the specific function. For example, the magnetic thin film of the permalloy manufactured by the plating method as a magnetic body is used for the thin film magnetic head of the hard disk drive which is enternal memory **** for computers. a permalloy is a typical soft magnetism thin film material -- especially [nickel] 82atomic%,[Fe] The point that the permalloy alloy which consists of 18atomic% has 0 or a negative magnetostriction constant is the special feature.
[0003]By the way, about the hard disk drive, the demand to large-scale-izing and a miniaturization is becoming strong every year, the densification of record progresses in connection with it, and the material which has higher saturation magnetic flux density has been required of the magnetic body of the head which reads this. However, in order to obtain the thing of higher saturation magnetic flux density with the magnetic thin film of a permalloy, it is necessary to make the content of Fe increase but, and if the content of Fe is made to increase too much, a magnetostriction constant will increase and reproduction performance will become unstable. Therefore, in the magnetic thin film of a mere permalloy, high saturation magnetic flux density-

ization has a limit.

[0004]On the other hand, [nickel] 82atomic%,[Fe] As a magnetic substance material which replaces a permalloy like 18atomic%, 3 element-system alloy of Co-nickel-Fe attracts attention. Drawing 4 is an explanatory view showing a presentation with a Co-nickel-Fe3 element-system alloy, and the distribution relation of saturation magnetic flux density. Since the presentation field shown in A has high saturation magnetic flux density and its magnetostriction constant is also small while being shown in this figure, it is expected that it is promising as a magnetic substance material of a thin film magnetic head. In U.S. Pat. No. 4,661,216, the magnetostriction constant is indicated by 0 about the magnetic thin film of the Co-nickel-Fe3 element-system alloy with high saturation magnetic flux density.

[0005]

[Problem(s) to be Solved by the Invention]However, in the presentation field of A of drawing 4 of the Co-nickel-Fe3 element-system alloy mentioned above, the value of effective specific resistance is as low as about 10micro ohm-cm. Therefore, there is a new problem which both the thin film magnetic heads using a Co-nickel-Fe3 element-system alloy have unstable write characteristic and reading characteristic in a high frequency region, and is said that they are inferior in high-frequency response. It is as follows when this point is explained in detail. That is, if a thin film magnetic head is exposed to a magnetization change, an eddy current will occur inside a magnetic body. And the eddy current which flows into the inside of a magnetic body increases as the frequency of a magnetization response of a thin film magnetic head increases (i.e., as the magnetization change per unit time of a thin film magnetic head increases). On the other hand, this eddy current produces magnetic flux which bars flux reversal according to Lenz's law. As a result, a magnetization change is controlled as a signal serves as high frequency. The eddy current which flows into the inside of a magnetic body here is inversely proportional to the specific resistance of a magnetic body.

[0006]And in the presentation field which the Co-nickel-Fe3 element-system alloy described above as mentioned above, since the value of effective specific resistance is low, when the write characteristic in a high frequency region and the reading characteristic become unstable and a thin film magnetic head is manufactured using this, high-frequency response will be inferior. High-frequency response was the characteristic indispensable to the magnetic substance material of a thin film magnetic head which can respond to high density recording, and it was a technical technical problem to raise specific resistance for adoption to the thin film magnetic head of a Co-nickel-Fe3 element-system alloy.

[0007]Although there are also a magnetic thin film (JP,61-264698,A) which has hetero amorphous 2-phase structure as a high-specific-resistance magnetic thin film excellent in high-frequency response, and a lamination magnetic thin film (JP,1-175707,A) which laminated the magnetic layer which has hetero amorphous 2-phase structure, and the non-magnetic layer, These films are

impossible for forming membranes in a plating process for amorphous structure as a matter of fact, and cannot but form membranes using dry processes, such as sputtering process. However, since a high vacuum is needed in a dry process, compared with a plating process, productive efficiency is bad. For sticking by the rise in heat in a dry process of resist indispensable to fine element formation furthermore, etc., a milling process must be used and a process becomes complicated. Therefore, the magnetic thin film which has hetero amorphous 2-phase structure, and the lamination magnetic thin film which laminated the magnetic layer which has hetero amorphous 2-phase structure, and the non-magnetic layer have a fault on productive efficiency, and it is hard to adopt it industrially.

[0008]Therefore, the practical use of the plating method which is excellent in productivity is possible, and the actual condition is that a magnetic thin film which has high specific resistance and high saturation magnetic flux density, and a manufacturing method for the same are not yet developed. Then, this invention utilizes electroplating paying attention to the problem which conventional technology described above, establishes the method of manufacturing the magnetic thin film of the soft magnetism which has high specific resistance and high saturation magnetic flux density, and it makes a technical problem development of the manufacturing method of the thin film magnetic head using this method. Namely, this invention is a magnetic thin film mainly used as a magnetic body of a thin film magnetic head which was excellent in writing and the reading performance, and fitted high-density magnetic recording, Let it be a technical problem to provide the manufacturing method of a magnetic thin film and a magnetic thin film which is manufactured by the plating method, saturation magnetic flux density is high, and is excellent in soft magnetic characteristics, and has high specific resistance.

[0009]

[Means for Solving the Problem]Although there is an advantage said that a magnetic thin film of a Co-nickel-Fe3 element-system alloy has high saturation magnetic flux density as described above, there is a fault said that specific resistance is small and a thin film magnetic head using this has unstable writing and reading characteristic in a high frequency region. Then, in order to obtain a magnetic thin film of plating which has high specific resistance, with an advantage of a Co-nickel-Fe3 element-system alloy that saturation magnetic flux density is high maintained, this invention persons, When carrying out plating membrane formation of the Co-nickel-Fe3 element-system alloy, it examined adding an additive agent during a plating bath and making silica and alumina contain in a plating film, and this invention was completed.

[0010]Namely, in a manufacturing method of a magnetic thin film which electroplates a treatment object and makes a magnetic thin film form on the surface of a treatment object during a plating bath, the invention according to claim 1 a plating bath, It is a manufacturing method of a magnetic thin film, wherein it contains two or more sorts of ion chosen from Fe^{2+} ion, $nickel^{2+}$ ion, and Co^{2+} ion and particles of an insulator are distributed during a plating bath.

[0011]An invention which materialized the invention according to claim 1 more, Two or more sorts of ion chosen from said Fe^{2+} ion, $nickel^{2+}$ ion, and Co^{2+} ion, It is supplied by sulfate and/or hydrochloride, and a plating bath is an acidic bath and particles of an insulator distributed during a plating bath are the manufacturing methods of the magnetic thin film according to claim 1 being a colloidal particle of SiO_2 and/or $aluminum_2O_3$.

[0012]An invention of a magnetic thin film which utilized the above-mentioned invention is the magnetic thin film which was manufactured by a manufacturing method of the magnetic thin film according to claim 1 or 2 and in which particles of an insulator were distributed in a thin film of a magnetic alloy.

[0013]One invention which will accept it in order to attain the still more nearly same purpose is a magnetic thin film, wherein SiO_2 and/or $aluminum_2O_3$ is distributed in a thin film of a Fe-Ni-Co alloy.

[0014]An invention which applied the above-mentioned invention to manufacture of a thin film magnetic head, In a manufacturing method of a thin film magnetic head which forms on a substrate two or more magnetic thin films and a conductor coil film which intervenes between these magnetic thin films, and constitutes a magnetic circuit with a magnetic thin film and a conductor coil film, Magnetic thin film much more at least is a manufacturing method of a thin film magnetic head forming membranes by a manufacturing method of the magnetic thin film according to claim 1 or 2.

[0015]Particles of an insulator are distributed in a thin film and a magnetic thin film manufactured by this invention and a magnetic thin film of this invention have high specific resistance. As mentioned above, since an eddy current which flows into an inside of a magnetic body is inversely proportional to specific resistance of a magnetic body, a magnetic thin film of this invention has high specific resistance of a magnetic body, and reduction of a magnetization change by an eddy current is controlled. Therefore, a thin film magnetic head which adopted a magnetic thin film of this invention is excellent in high-frequency response.

[0016]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described. Drawing 1 is a mimetic diagram explaining the structure of the magnetic thin film of this invention.

[0017]This invention applies electroplating art and forms the thin film of a magnetic alloy on the surface of a treatment object. The plating bath used for this invention contains two or more sorts of ion chosen from Fe^{2+} ion, $nickel^{2+}$ ion, and Co^{2+} ion. Electrocrystallization of this ion is carried out on the surface of a treatment object, and it constitutes an alloy. As for the plating bath which excelling most makes carry out electrocrystallization of the Co-nickel-Fe3 element-system alloy as a mode of this invention, and is used for this invention from this point, it is desirable to include all Fe^{2+} ion, the $nickel^{2+}$ ion, and Co^{2+} ion.

[0018]Here the supply source of Fe^{2+} ion Ferrous sulfate ($FeSO_4$and7H_2O), Ferrous chloride ($FeCl_2$and4H_2O) and the first iron ($Fe(NO_3)_2$) of nitric acid, The dim-ized first iron ($Fe(BF_4)_2$), the first iron ($Fe(SO_3$ and $NH_2)_2$) of sulfamic acid, etc. are mentioned, and they are used by these, mixing independently or selectively. And adoption of ferrous sulfate ($FeSO_4$and7H_2O) or ferrous chloride ($FeCl_2$and4H_2O) is desirable as a supply source of Fe^{2+} ion at the point said that the density of a thin film becomes high in this invention. The supply source of most suitable Fe^{2+} ion is ferrous sulfate ($FeSO_4$and7H_2O), as ordinarily used for magnetic plating.

[0019]The supply source of $nickel^{2+}$ ion Nickel sulfate ($NiSO_4$and6H_2O), Nickel chloride ($NiSO_4$and6H_2O) and formic acid nickel (nickel(COOH)$_2$), Nickel amiosulfonate (nickel(NH_2SO_3)$_2$) Dim-ized nickel (nickel(BF_4)$_2$), nickel bromide ($NiBr_2$), etc. are mentioned, and they are used by these, mixing independently or selectively. And in this invention, nickel sulfate ($NiSO_4$and6H_2O) and nickel chloride ($NiCl_2$and6H_2O) ** ordinarily used for an alloy plating is most suitable as a supply source of $nickel^{2+}$ ion.

[0020]It is used cobalt sulfate ($CoSO_4$and7H_2O), a cobalt chloride ($CoCl_2$and6H_2O), etc. being still more independent as a supply source of Co^{2+} ion, or mixing.

[0021]As characteristic composition of this invention, the particles of the insulator are distributed during the plating bath. As particles of an insulator, SiO_2 and $aluminum_2O_3$, CrO_3, TiO_2ZrO_2, SiC, Si_3N_4, WC, ZrB_2, and CrB are mentioned. Although the particles of the above-mentioned insulator can be used mixing independently or selectively, using SiO_2 or $aluminum_2O_3$ alone especially is recommended.

[0022]10 to about 30 nm is suitable for the particle diameter of SiO_2 and $aluminum_2O_3$.

[0023]SiO_2 or $aluminum_2O_3$ -- concrete -- silica -- by blending sol or alumina sol during a plating bath, it is mixed during a plating bath, and these serve as a colloidal particle and are distributed during a plating bath.

[0024]If SiO_2 (silica) or $aluminum_2O_3$ (alumina) is made to contain and a treatment object is electroplated during a plating bath, including all Fe^{2+} ion, the $nickel^{2+}$ ion, and Co^{2+} ion, On the surface of a treatment object, with a Co-nickel-Fe3 element-system alloy-plating film, a magnetic thin film is formed and SiO_2 or $aluminum_2O_3$ is further distributed in it. It seems to be drawing 1 when the structure of the magnetic thin film manufactured by the manufacturing method of the magnetic thin film of this embodiment is drawn typically. namely, -- the magnetic thin film 1 of this

embodiment -- the inside of the Co-nickel-Fe3 element-system alloy 2 (magnetic body) -- an insulator -- silica or the alumina 3 is distributed.

[0025]As a result, the specific resistance of a Co-nickel-Fe3 element-system alloy-plating film increases.

[0026]The content of the Fe^{2+} ion under plating bath, $nickel^{2+}$ ion, and Co^{2+} ion is adjusted according to plating conditions. In order to obtain a film with a smaller magnetostriction constant here, the lower one of the Fe concentration in a film is good. The concentration of the silica under plating bath or alumina is adjusted according to plating conditions. As for pH of a plating bath, in order to obtain higher saturation magnetic flux density, it is desirable that it is [or more 2] four or less. That is, in pH of a plating bath, oxidation of Fe^{2+} may start or more by four. When pH of a plating bath is two or less conversely, while hydrogen occurs on the surface of a treatment object and control of thickness becomes difficult, it may become the magnetic thin film ruined [the surface's].

[0027]In order to obtain further more high saturation magnetic flux density, it is desirable for the content of Co in the magnetic body 2 to be more than 50wt%, and for a Fe content to be more than 5wt%. As for Co content, in order to obtain outstanding soft magnetic characteristics, it is [the content of less than 90wt% and Fe] desirable that it is less than 30wt%. Putting these points together, the content of Co in a magnetic thin film is 50wt% to 90wt%, and, as for the content of Fe, it is desirable that it is 5wt% to 30wt%.

[0028]As for the rate of the silica or alumina closed into the magnetic thin film 1, in order to make the fall of saturation magnetic flux density into 20% or less, it is desirable that it is less than 20wt%.

[0029]In order to obtain soft magnetic characteristics outstanding furthermore, impressing a magnetic field during plating membrane formation is recommended. More specifically, it is desirable to impress a magnetic field of 50 gauss or more. As for the current density at the time of plating, in order to obtain the still smoother surface, it is desirable that it is below 6.0 mA/cm^2.

[0030]Next, the embodiment which applied the manufacturing method of the above-mentioned magnetic thin film to manufacture of the thin film magnetic head is explained. Drawing 2 is an outline perspective view of the thin film magnetic head manufactured by this invention. Drawing 3 is drawing of longitudinal section of the thin film magnetic head of drawing 2.

[0031]The thin film magnetic head 10 uses as a base the substrate (treatment object) 11 which consists of ceramics of $aluminum_2O_3$-TiC, etc. as everyone knows, the insulator layer 12 is formed on the substrate 11, and the layer which constitutes a magnetic circuit on it further is laminated. namely, -- the thin film magnetic head 11 has the lower magnetic thin film 15 and the top magnetic thin film 16 -- between both -- the gap film 17 and the insulator layers 18, 19, and 20 -- and -- The conductor coil films 22 and 23 intervene.

[0032]And the lower magnetic thin film 15 and the top magnetic thin film 16 are combined in rear gap 25 back portion. The front end side of the lower magnetic thin film 15 and the top magnetic thin film 16 confronts each other via the gap film 17, and constitutes the magnetic gap from portion concerned. The connecting part 25 of the lower magnetic thin film 15 and the top magnetic thin film 16, i.e., a rear gap, is spirally formed in the conductor coil film 22 as a center.

[0033]The manufacturing process of the thin film magnetic head adapting this invention is as follows. That is, predetermined pretreatment is performed to the substrate 11 which consists of ceramics of aluminum$_2O_3$-TiC, etc., and the insulator layer 12 of aluminum$_2O_3$ is laminated by sputtering to it. And although the lower magnetic thin film 15 is laminated on this insulator layer 12, the manufacturing method of the magnetic thin film mentioned above in this laminating process is applied. A plating ground film (not shown) is provided in the surface of the insulator layer 12, and, specifically, photoresist is applied by spin coating or other means on it. And a photo mask is arranged and exposed on photoresist, negatives are developed further, and the resist frame of specified shape is patterned after the surface of the insulator layer 12.

[0034]Then, this substrate 11 is immersed in a barrel-plating tub, and electroplating is performed. The plating bath of this barrel-plating tub makes SiO_2 (silica) or aluminum$_2O_3$ (alumina) contain including all Fe^{2+} ion, the nickel^{2+} ion, and Co^{2+} ion. In electroplating, a resist frame serves as a mask and the lower magnetic thin film 15 of a prescribed pattern is formed. And this lower magnetic thin film 15 is a Co-nickel-Fe3 element-system alloy, and SiO_2 or aluminum$_2O_3$ is distributed in it.

[0035]Then, publicly known etching removes a resist frame and an excessive plating ground film. Then, the gap film 17 of aluminum$_2O_3$ is laminated by publicly known sputtering. Then, the insulator layer 18 is laminated. the insulator layer 18 is the layer which comprised organic insulating resin, such as novolak resin, apply and carry out soft bake of the novolak resin etc. on said lower magnetic thin film 15 carried out and the gap film 17, apply and expose a photo mask, and pass development and heat treatment -- it is formed.

[0036]The conductor coil film 22 of Cu is laminated on it. Publicly known electroplating art is used for lamination of the conductor coil film 22. the pattern formation means of the conductor coil film 22 -- the case of said lower magnetic thin film 15 carried out -- abbreviated -- it is the same. Then, lamination of an insulator layer and lamination of a conductor coil film are repeated, and the insulator layers 19 and 20 and the conductor coil film 23 are formed.

[0037]Furthermore on it, the top magnetic thin film 16 is laminated. The lamination means of the top magnetic thin film 16 is the same as that of the above mentioned lower magnetic thin film 15, All Fe^{2+} ion, the nickel^{2+} ion, and Co^{2+} ion are included, And electroplating is performed during the plating bath which SiO_2 (silica) or aluminum$_2O_3$ (alumina) contained, and the layer by which

SiO_2 or aluminum$_2O_3$ was distributed in the Co-nickel-Fe3 element-system alloy is made to form.

[0038]And on it, the protective layers 21, such as aluminum$_2O_3$, are formed by methods, such as sputtering.

[0039]Thus, the manufactured thin film magnetic head 10 has the high specific resistance of the magnetic thin films 15 and 16, and its saturation magnetic flux density is high, and it is excellent also in soft magnetic characteristics. Therefore, the thin film magnetic head 10 has a write characteristic in a high frequency region, and the stable reading characteristic, and high-frequency response is excellent.

[0040]

[Example]The experiment which checks the example of this invention and the effect of this invention further below and which was conducted for accumulating is explained. This example carries out on the assumption that this invention is applied to a thin film magnetic head, and a treatment object is a wafer. The permalloy alloy film (about 1000A in thickness) was made to form in a wafer as a ground film by a sputtering technique when using it using the ceramics of a glass substrate or aluminum$_2O_3$-TiC.

[0041]Combination of the plating bath used for the experiment is as in Table 1.

[0042]

[Table 1]

メッキ浴の配合

浴成分	配合量
硫酸第一鉄（$FeSO_4 \cdot 7H_2O$）	0．1mol/リットル
硫酸ニッケル（$NiSO_4 \cdot 6H_2O$）	0．115mol/リットル
塩化ニッケル（$NiSO_4 \cdot 6H_2O$）	0．115mol/リットル
硫酸コバルト（$CoSO_4 \cdot 7H_2O$）	0．055mol/リットル
塩化コバルト（$CoCl_2 \cdot 6H_2O$）	0．055mol/リットル
ほう酸（H_3BO_3）	1．0mol/リットル
サッカリンナトリウム	1．5g/リットル
ドデシル硫酸ナトリウム	0．1g/リットル
シリカゾル	表2の通り
アルミナゾル	表3の通り

[0043]Way acid is blended as a buffer for pH among Table 1. Saccharin sodium is blended for stress reduction of a plating thin film, and sodium dodecyl sulfate is blended as a surface-active agent of a plating film. In addition to table 1, chloride is added for pH regulation of plating liquid, and pH of the plating bath is adjusted to 3.0. [0044]and the plating bath of this combination -- silica -- from 0.08g/l. to 23.4g/l., sol was divided into six steps, and was blended, and electroplating was

given to the wafer. the blended silica -- the silicic acid anhydride (SiO_2) is contained in sol 20%. Therefore, six steps of silicic acid anhydrides are contained in the plating bath from 0.016g/l. to 4.6g/l.

[0045]The temperature of plating liquid was set as 35**0.1 with the electronic thermoregulator. The plating liquid amount of supply to the plating tub was 4 l./m. Current density was maintained below at 6.0 mA/cm^2.

[0046]As a result, the magnetic thin film of the Co-nickel-Fe3 element-system alloy was formed on the wafer of a glass substrate. And the film composition, magnetic properties, and specific resistance of this magnetic thin film were measured. The result was as in Table 2.

[0047]

[Table 2]

めっき浴中のシリカゾル濃度と磁性薄膜の特性

	No	浴シリカゾル 濃度 (g/リットル)	磁性膜組成[wt%] Co	Ni	Fe	磁気特性 Bs[T]	Hc[Oe]	Hk[Oe]	比抵抗 (μΩcm)
比較例		0 (0)	73.67	18.61	7.62	1.8	0.8	13	12
実施例	1	0.08(0.016)	74.21	19.91	5.89	1.8	0.9	12	12
	2	0.31(0.062)	74.91	18.71	6.38	1.6	0.9	13	14
	3	0.82(0.164)	74.29	18.92	6.80	1.6	0.6	14	14
	4	3.32(0.664)	75.23	19.26	5.52	1.5	0.8	14	14
	5	8.29(1.658)	75.40	18.94	5.66	1.5	1.1	14	14
	6	23.4(4.68)	75.17	18.56	6.27	1.5	0.8	14	15

括弧内は、めっき浴中のＳｉＯ₂の濃度

[0048]under [from Table 2] a plating bath -- silica -- by adding sol, he can understand that the specific resistance of a plating film goes up notably. the silica under plating bath from a viewpoint of raising the specific resistance of a plating film -- sol -- it can be said that more ones of quantity are good.

[0049]however, the silica under [an experiment to] plating bath -- when the quantity of sol increased, it also turned out that saturation magnetic flux density decreases in monotone. Therefore, the optimum amount of the silicic acid anhydride under plating bath is 23g/l. from 0.31.

[0050]silica -- alumina sol was blended instead of sol and same measurement was performed. The result seemed to be Table 3.

[0051]

[Table 3]

めっき浴中のアルミナゾル濃度と磁性薄膜の特性

	No	浴アルミナゾル濃度 [g/リットル]	磁性膜組成[wt%] Co	Ni	Fe	磁気特性 Bs[T]	Hc[Oe]	Hk[Oe]	比抵抗 [μΩcm]
比較例		0	73.67	18.61	7.62	1.8	0.8	13	12
実施例	1	0.05(0.01)	74.07	18.13	7.80	1.7	1.2	13	13
	2	0.3 (0.06)	74.47	17.99	7.53	1.7	0.9	13	13
	3	0.8 (0.16)	74.57	17.98	7.45	1.6	0.9	13	14
	4	3.3 (0.66)	74.44	19.07	6.49	1.4	1.4	12	15
	5	8.3 (1.66)	74.38	18.75	6.87	1.4	1.3	12	19
	6	23.3(4.66)	74.20	18.70	7.10	1.4	1.2	12	17

括弧内は、めっき浴中のAl_2O_3の濃度

[0052]the case where alumina sol is used -- silica -- when the specific resistance of the plating film went up notably and the quantity of the alumina sol under plating bath increased by seeing the same tendency as the case where sol is added during a bath, and adding alumina sol during a plating bath, it turned out that saturation magnetic flux density decreases in monotone.
[0053]Therefore, the optimum amount of alumina under plating bath is 8.3g/l. from 0.8.
[0054]
[Effect of the Invention]Saturation magnetic flux density is high, the magnetic thin film of this invention is excellent in soft magnetic characteristics, and its specific resistance is large. Therefore, the thin film magnetic head which the magnetic thin film of this invention was suitable as a magnetic body of a thin film magnetic head, and adopted the magnetic thin film of this invention is excellent in writing and reading performance, and its high-frequency response is good.

[0055]The manufacturing method of the magnetic thin film of this invention uses electroplating, and it excels in soft magnetic characteristics, and it has an effect whose mass production of a magnetic thin film with large specific resistance is attained.
[0056]Furthermore, the thin film magnetic head of this invention is excellent in writing and reading performance, and has the outstanding effect that high-frequency response is good.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention]This invention relates to the manufacturing method of a magnetic thin film and a magnetic thin film. The magnetic thin film of this invention is used as the magnetic body of a thin film magnetic head suitable for high-density magnetic recording, and magnetic shielding, its saturation magnetic flux density is high, and it is excellent in soft magnetic characteristics, and has high specific resistance. This invention relates to the manufacturing method of a thin film magnetic head collectively.

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PRIOR ART

[Description of the Prior Art]In recent years, the thin film by plating is broadly used for electronic parts etc. as a functionality thin film provided not only with the object for an ornament, or the object for corrosion prevention but the specific function. For example, the magnetic thin film of the permalloy manufactured by the plating method as a magnetic body is used for the thin film magnetic head of the hard disk drive which is enternal memory **** for computers. a permalloy is a typical soft magnetism thin film material -- especially [nickel] 82atomic%,[Fe] The point that the permalloy alloy which consists of 18atomic% has 0 or a negative magnetostriction constant is the special feature.
[0003]By the way, about the hard disk drive, the demand to large-scale-izing and a miniaturization is becoming strong every year, the densification of record progresses in connection with it, and the material which has higher saturation magnetic flux density has been required of the magnetic body of the head which reads this. However, in order to obtain the thing of higher saturation magnetic flux density with the magnetic thin film of a permalloy, it is necessary to make the content of Fe increase but, and if the content of Fe is made to increase too much, a magnetostriction constant will increase and reproduction performance will become unstable. Therefore, in the magnetic thin film of a mere permalloy, high saturation magnetic flux density-ization has a limit.
[0004]On the other hand, [nickel] 82atomic%,[Fe] As a magnetic substance material which replaces a permalloy like 18atomic%, 3 element-system alloy of Co-nickel-Fe attracts attention. Drawing 4 is an explanatory view showing a presentation with a Co-nickel-Fe3 element-system alloy, and the distribution relation of saturation magnetic flux density. Since the presentation field shown in A has high saturation magnetic flux density and its magnetostriction constant is also small while being shown in this figure, it is expected that it is promising as a magnetic substance material of a thin film magnetic head. In U.S. Pat. No. 4,661,216, the magnetostriction constant is indicated by 0 about the magnetic thin film of the Co-nickel-Fe3 element-system alloy with high

saturation magnetic flux density.

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EFFECT OF THE INVENTION

[Effect of the Invention]Saturation magnetic flux density is high, the magnetic thin film of this invention is excellent in soft magnetic characteristics, and its specific resistance is large. Therefore, the thin film magnetic head which the magnetic thin film of this invention was suitable as a magnetic body of a thin film magnetic head, and adopted the magnetic thin film of this invention is excellent in writing and reading performance, and its high-frequency response is good.

[0055]The manufacturing method of the magnetic thin film of this invention uses electroplating, and it excels in soft magnetic characteristics, and it has an effect whose mass production of a magnetic thin film with large specific resistance is attained.
[0056]Furthermore, the thin film magnetic head of this invention is excellent in writing and reading performance, and has the outstanding effect that high-frequency response is good.

[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, in the presentation field of A of drawing 4 of the Co-nickel-Fe3 element-system alloy mentioned above, the value of effective specific resistance is as low as about 10micro ohm-cm. Therefore, there is a new problem which both the thin film magnetic heads using a Co-nickel-Fe3 element-system alloy have unstable write characteristic and reading characteristic in a high frequency region, and is said that they are inferior in high-frequency response. It is as follows when this point is explained in detail. That is, if a thin film magnetic head is exposed to a magnetization change, an eddy current will occur inside a magnetic body. And the eddy current which flows into the inside of a magnetic body increases as the frequency of a magnetization response of a thin film magnetic head increases (i.e., as the magnetization change per unit time of a thin film magnetic head increases). On the other hand, this eddy current produces magnetic flux which bars flux reversal according to Lenz's law. As a result, a magnetization change is controlled as a signal serves as high frequency. The eddy current which flows into the inside of a magnetic body here is inversely proportional to the specific resistance of a magnetic body.

[0006]And in the presentation field which the Co-nickel-Fe3 element-system alloy described above as mentioned above, since the value of effective specific resistance is low, when the write characteristic in a high frequency region and the reading characteristic become unstable and a thin film magnetic head is manufactured using this, high-frequency response will be inferior. High-frequency response was the characteristic indispensable to the magnetic substance material of a thin film magnetic head which can respond to high density recording, and it was a technical technical problem to raise specific resistance for adoption to the thin film magnetic head of a Co-nickel-Fe3 element-system alloy.

[0007]Although there are also a magnetic thin film (JP,61-264698,A) which has hetero amorphous 2-phase structure as a high-specific-resistance magnetic thin film excellent in high-frequency response, and a lamination magnetic thin film (JP,1-175707,A) which laminated the magnetic

layer which has hetero amorphous 2-phase structure, and the non-magnetic layer, These films are impossible for forming membranes in a plating process for amorphous structure as a matter of fact, and cannot but form membranes using dry processes, such as sputtering process. However, since a high vacuum is needed in a dry process, compared with a plating process, productive efficiency is bad. For sticking by the rise in heat in a dry process of resist indispensable to fine element formation furthermore, etc., a milling process must be used and a process becomes complicated. Therefore, the magnetic thin film which has hetero amorphous 2-phase structure, and the lamination magnetic thin film which laminated the magnetic layer which has hetero amorphous 2-phase structure, and the non-magnetic layer have a fault on productive efficiency, and it is hard to adopt it industrially.

[0008]Therefore, the practical use of the plating method which is excellent in productivity is possible, and the actual condition is that a magnetic thin film which has high specific resistance and high saturation magnetic flux density, and a manufacturing method for the same are not yet developed. Then, this invention utilizes electroplating paying attention to the problem which conventional technology described above, establishes the method of manufacturing the magnetic thin film of the soft magnetism which has high specific resistance and high saturation magnetic flux density, and it makes a technical problem development of the manufacturing method of the thin film magnetic head using this method. Namely, this invention is a magnetic thin film mainly used as a magnetic body of a thin film magnetic head which was excellent in writing and the reading performance, and fitted high-density magnetic recording, Let it be a technical problem to provide the manufacturing method of a magnetic thin film and a magnetic thin film which is manufactured by the plating method, saturation magnetic flux density is high, and is excellent in soft magnetic characteristics, and has high specific resistance.

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MEANS

[Means for Solving the Problem]Although there is an advantage said that a magnetic thin film of a Co-nickel-Fe3 element-system alloy has high saturation magnetic flux density as described above, there is a fault said that specific resistance is small and a thin film magnetic head using this has unstable writing and reading characteristic in a high frequency region. Then, in order to obtain a magnetic thin film of plating which has high specific resistance, with an advantage of a Co-nickel-Fe3 element-system alloy that saturation magnetic flux density is high maintained, this invention persons, When carrying out plating membrane formation of the Co-nickel-Fe3 element-system alloy, it examined adding an additive agent during a plating bath and making silica and alumina contain in a plating film, and this invention was completed.

[0010]Namely, in a manufacturing method of a magnetic thin film which electroplates a treatment object and makes a magnetic thin film form on the surface of a treatment object during a plating bath, the invention according to claim 1 a plating bath, It is a manufacturing method of a magnetic thin film, wherein it contains two or more sorts of ion chosen from Fe^{2+} ion, nickel^{2+} ion, and Co^{2+} ion and particles of an insulator are distributed during a plating bath.

[0011]An invention which materialized the invention according to claim 1 more, Two or more sorts of ion chosen from said Fe^{2+} ion, nickel^{2+} ion, and Co^{2+} ion, It is supplied by sulfate and/or hydrochloride, and a plating bath is an acidic bath and particles of an insulator distributed during a plating bath are the manufacturing methods of the magnetic thin film according to claim 1 being a colloidal particle of SiO_2 and/or aluminum$_2O_3$.

[0012]An invention of a magnetic thin film which utilized the above-mentioned invention is the magnetic thin film which was manufactured by a manufacturing method of the magnetic thin film according to claim 1 or 2 and in which particles of an insulator were distributed in a thin film of a magnetic alloy.

[0013]One invention which will accept it in order to attain the still more nearly same purpose is a

magnetic thin film, wherein SiO_2 and/or aluminum$_2O_3$ is distributed in a thin film of a Fe-Ni-Co alloy.

[0014]An invention which applied the above-mentioned invention to manufacture of a thin film magnetic head, In a manufacturing method of a thin film magnetic head which forms on a substrate two or more magnetic thin films and a conductor coil film which intervenes between these magnetic thin films, and constitutes a magnetic circuit with a magnetic thin film and a conductor coil film, Magnetic thin film much more at least is a manufacturing method of a thin film magnetic head forming membranes by a manufacturing method of the magnetic thin film according to claim 1 or 2.

[0015]Particles of an insulator are distributed in a thin film and a magnetic thin film manufactured by this invention and a magnetic thin film of this invention have high specific resistance. As mentioned above, since an eddy current which flows into an inside of a magnetic body is inversely proportional to specific resistance of a magnetic body, a magnetic thin film of this invention has high specific resistance of a magnetic body, and reduction of a magnetization change by an eddy current is controlled. Therefore, a thin film magnetic head which adopted a magnetic thin film of this invention is excellent in high-frequency response.

[0016]

[Embodiment of the Invention]Hereafter, an embodiment of the invention is described. Drawing 1 is a mimetic diagram explaining the structure of the magnetic thin film of this invention.

[0017]This invention applies electroplating art and forms the thin film of a magnetic alloy on the surface of a treatment object. The plating bath used for this invention contains two or more sorts of ion chosen from Fe^{2+} ion, nickel^{2+} ion, and Co^{2+} ion. Electrocrystallization of this ion is carried out on the surface of a treatment object, and it constitutes an alloy. As for the plating bath which excelling most makes carry out electrocrystallization of the Co-nickel-Fe3 element-system alloy as a mode of this invention, and is used for this invention from this point, it is desirable to include all Fe^{2+} ion, the nickel^{2+} ion, and Co^{2+} ion.

[0018]Here the supply source of Fe^{2+} ion Ferrous sulfate ($FeSO_4$and7H_2O), Ferrous chloride ($FeCl_2$and4H_2O) and the first iron ($Fe(NO_3)_2$) of nitric acid, The dim-ized first iron ($Fe(BF_4)_2$), the first iron ($Fe(SO_3$ and $NH_2)_2$) of sulfamic acid, etc. are mentioned, and they are used by these, mixing independently or selectively. And adoption of ferrous sulfate ($FeSO_4$and7H_2O) or ferrous chloride ($FeCl_2$and4H_2O) is desirable as a supply source of Fe^{2+} ion at the point said that the density of a thin film becomes high in this invention. The supply source of most suitable Fe^{2+} ion is ferrous sulfate ($FeSO_4$and7H_2O), as ordinarily used for magnetic plating.

[0019]The supply source of nickel^{2+} ion Nickel sulfate ($NiSO_4$and6H_2O), Nickel chloride ($NiSO_4$and6H_2O) and formic acid nickel (nickel(COOH) $_2$), Nickel amiosulfonate (nickel(NH_2SO_3) $_2$) Dim-ized nickel (nickel(BF_4) $_2$), nickel bromide ($NiBr_2$), etc. are mentioned, and they are used by these, mixing independently or selectively. And in this invention, nickel sulfate ($NiSO_4$and6H_2O) and nickel chloride ($NiCl_2$and6H_2O) ** ordinarily used for an alloy plating is most suitable as a supply source of nickel^{2+} ion.

[0020]It is used cobalt sulfate ($CoSO_4$and7H_2O), a cobalt chloride ($CoCl_2$and6H_2O), etc. being still more independent as a supply source of Co^{2+} ion, or mixing.

[0021]As characteristic composition of this invention, the particles of the insulator are distributed during the plating bath. As particles of an insulator, SiO_2 and aluminum$_2O_3$, CrO_3, TiO_2ZrO_2, SiC, Si_3N_4, WC, ZrB_2, and CrB are mentioned. Although the particles of the above-mentioned insulator can be used mixing independently or selectively, using SiO_2 or aluminum$_2O_3$ alone especially is recommended.

[0022]10 to about 30 nm is suitable for the particle diameter of SiO_2 and aluminum$_2O_3$.

[0023]SiO_2 or aluminum$_2O_3$ -- concrete -- silica -- by blending sol or alumina sol during a plating bath, it is mixed during a plating bath, and these serve as a colloidal particle and are distributed during a plating bath.

[0024]If SiO_2 (silica) or aluminum$_2O_3$ (alumina) is made to contain and a treatment object is electroplated during a plating bath, including all Fe^{2+} ion, the nickel^{2+} ion, and Co^{2+} ion, On the surface of a treatment object, with a Co-nickel-Fe3 element-system alloy-plating film, a magnetic thin film is formed and SiO_2 or aluminum$_2O_3$ is further distributed in it. It seems to be drawing 1 when the structure of the magnetic thin film manufactured by the manufacturing method of the magnetic thin film of this embodiment is drawn typically. namely, -- the magnetic thin film 1 of this embodiment -- the inside of the Co-nickel-Fe3 element-system alloy 2 (magnetic body) -- an insulator -- silica or the alumina 3 is distributed.

[0025]As a result, the specific resistance of a Co-nickel-Fe3 element-system alloy-plating film increases.

[0026]The content of the Fe^{2+} ion under plating bath, nickel^{2+} ion, and Co^{2+} ion is adjusted according to plating conditions. In order to obtain a film with a smaller magnetostriction constant here, the lower one of the Fe concentration in a film is good. The concentration of the silica under plating bath or alumina is adjusted according to plating conditions. As for pH of a plating bath, in order to obtain higher saturation magnetic flux density, it is desirable that it is [or more 2] four or

less. That is, in pH of a plating bath, oxidation of Fe^{2+} may start or more by four. When pH of a plating bath is two or less conversely, while hydrogen occurs on the surface of a treatment object and control of thickness becomes difficult, it may become the magnetic thin film ruined [the surface's].

[0027]In order to obtain further more high saturation magnetic flux density, it is desirable for the content of Co in the magnetic body 2 to be more than 50wt%, and for a Fe content to be more than 5wt%. As for Co content, in order to obtain outstanding soft magnetic characteristics, it is [the content of less than 90wt% and Fe] desirable that it is less than 30wt%. Putting these points together, the content of Co in a magnetic thin film is 50wt% to 90wt%, and, as for the content of Fe, it is desirable that it is 5wt% to 30wt%.

[0028]As for the rate of the silica or alumina closed into the magnetic thin film 1, in order to make the fall of saturation magnetic flux density into 20% or less, it is desirable that it is less than 20wt%.

[0029]In order to obtain soft magnetic characteristics outstanding furthermore, impressing a magnetic field during plating membrane formation is recommended. More specifically, it is desirable to impress a magnetic field of 50 gauss or more. As for the current density at the time of plating, in order to obtain the still smoother surface, it is desirable that it is below 6.0 mA/cm^2.

[0030]Next, the embodiment which applied the manufacturing method of the above-mentioned magnetic thin film to manufacture of the thin film magnetic head is explained. Drawing 2 is an outline perspective view of the thin film magnetic head manufactured by this invention. Drawing 3 is drawing of longitudinal section of the thin film magnetic head of drawing 2.

[0031]The thin film magnetic head 10 uses as a base the substrate (treatment object) 11 which consists of ceramics of aluminum$_2O_3$-TiC, etc. as everyone knows, the insulator layer 12 is formed on the substrate 11, and the layer which constitutes a magnetic circuit on it further is laminated. namely, -- the thin film magnetic head 11 has the lower magnetic thin film 15 and the top magnetic thin film 16 -- between both -- the gap film 17 and the insulator layers 18, 19, and 20 -- and -- The conductor coil films 22 and 23 intervene.

[0032]And the lower magnetic thin film 15 and the top magnetic thin film 16 are combined in rear gap 25 back portion. The front end side of the lower magnetic thin film 15 and the top magnetic thin film 16 confronts each other via the gap film 17, and constitutes the magnetic gap from portion concerned. The connecting part 25 of the lower magnetic thin film 15 and the top magnetic thin film 16, i.e., a rear gap, is spirally formed in the conductor coil film 22 as a center.

[0033]The manufacturing process of the thin film magnetic head adapting this invention is as follows. That is, predetermined pretreatment is performed to the substrate 11 which consists of ceramics of aluminum$_2O_3$-TiC, etc., and the insulator layer 12 of aluminum$_2O_3$ is laminated by sputtering to it. And although the lower magnetic thin film 15 is laminated on this insulator layer

12, the manufacturing method of the magnetic thin film mentioned above in this laminating process is applied. A plating ground film (not shown) is provided in the surface of the insulator layer 12, and, specifically, photoresist is applied by spin coating or other means on it. And a photo mask is arranged and exposed on photoresist, negatives are developed further, and the resist frame of specified shape is patterned after the surface of the insulator layer 12.

[0034]Then, this substrate 11 is immersed in a barrel-plating tub, and electroplating is performed. The plating bath of this barrel-plating tub makes SiO_2 (silica) or aluminum$_2O_3$ (alumina) contain including all Fe^{2+} ion, the nickel^{2+} ion, and Co^{2+} ion. In electroplating, a resist frame serves as a mask and the lower magnetic thin film 15 of a prescribed pattern is formed. And this lower magnetic thin film 15 is a Co-nickel-Fe3 element-system alloy, and SiO_2 or aluminum$_2O_3$ is distributed in it.

[0035]Then, publicly known etching removes a resist frame and an excessive plating ground film. Then, the gap film 17 of aluminum$_2O_3$ is laminated by publicly known sputtering. Then, the insulator layer 18 is laminated. the insulator layer 18 is the layer which comprised organic insulating resin, such as novolak resin, apply and carry out soft bake of the novolak resin etc. on said lower magnetic thin film 15 carried out and the gap film 17, apply and expose a photo mask, and pass development and heat treatment -- it is formed.

[0036]The conductor coil film 22 of Cu is laminated on it. Publicly known electroplating art is used for lamination of the conductor coil film 22. the pattern formation means of the conductor coil film 22 -- the case of said lower magnetic thin film 15 carried out -- abbreviated -- it is the same. Then, lamination of an insulator layer and lamination of a conductor coil film are repeated, and the insulator layers 19 and 20 and the conductor coil film 23 are formed.

[0037]Furthermore on it, the top magnetic thin film 16 is laminated. The lamination means of the top magnetic thin film 16 is the same as that of the above mentioned lower magnetic thin film 15, All Fe^{2+} ion, the nickel^{2+} ion, and Co^{2+} ion are included, And electroplating is performed during the plating bath which SiO_2 (silica) or aluminum$_2O_3$ (alumina) contained, and the layer by which SiO_2 or aluminum$_2O_3$ was distributed in the Co-nickel-Fe3 element-system alloy is made to form.

[0038]And on it, the protective layers 21, such as aluminum$_2O_3$, are formed by methods, such as sputtering.

[0039]Thus, the manufactured thin film magnetic head 10 has the high specific resistance of the magnetic thin films 15 and 16, and its saturation magnetic flux density is high, and it is excellent also in soft magnetic characteristics. Therefore, the thin film magnetic head 10 has a write characteristic in a high frequency region, and the stable reading characteristic, and high-frequency response is excellent.

[Translation done.]

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EXAMPLE

[Example]The experiment which checks the example of this invention and the effect of this invention further below and which was conducted for accumulating is explained. This example carries out on the assumption that this invention is applied to a thin film magnetic head, and a treatment object is a wafer. The permalloy alloy film (about 1000A in thickness) was made to form in a wafer as a ground film by a sputtering technique when using it using the ceramics of a glass substrate or aluminum$_2O_3$-TiC.

[0041]Combination of the plating bath used for the experiment is as in Table 1.

[0042]

[Table 1]

メッキ浴の配合

浴成分	配合量
硫酸第一鉄（$FeSO_4 \cdot 7H_2O$）	0．1mol/リットル
硫酸ニッケル（$NiSO_4 \cdot 6H_2O$）	0．115mol/リットル
塩化ニッケル（$NiSO_4 \cdot 6H_2O$）	0．115mol/リットル
硫酸コバルト（$CoSO_4 \cdot 7H_2O$）	0．055mol/リットル
塩化コバルト（$CoCl_2 \cdot 6H_2O$）	0．055mol/リットル
ほう酸（H_3BO_3）	1．0mol/リットル
サッカリンナトリウム	1．5g/リットル
ドデシル硫酸ナトリウム	0．1g/リットル
シリカゾル	表2の通り
アルミナゾル	表3の通り

[0043]Way acid is blended as a buffer for pH among Table 1. Saccharin sodium is blended for stress reduction of a plating thin film, and sodium dodecyl sulfate is blended as a surface-active agent of a plating film. In addition to table 1, chloride is added for pH regulation of plating liquid,

and pH of the plating bath is adjusted to 3.0. [0044]and the plating bath of this combination -- silica -- from 0.08g/l. to 23.4g/l., sol was divided into six steps, and was blended, and electroplating was given to the wafer. the blended silica -- the silicic acid anhydride (SiO_2) is contained in sol 20%. Therefore, six steps of silicic acid anhydrides are contained in the plating bath from 0.016g/l. to 4.6g/l.

[0045]The temperature of plating liquid was set as 35**0.1 with the electronic thermoregulator. The plating liquid amount of supply to the plating tub was 4 l./m. Current density was maintained below at 6.0 mA/cm^2.

[0046]As a result, the magnetic thin film of the Co-nickel-Fe3 element-system alloy was formed on the wafer of a glass substrate. And the film composition, magnetic properties, and specific resistance of this magnetic thin film were measured. The result was as in Table 2.

[0047]

[Table 2]

めっき浴中のシリカゾル濃度と磁性薄膜の特性

	No	浴シリカゾル濃度 (g/リットル)	磁性膜組成[wt%] Co	Ni	Fe	磁気特性 Bs[T]	Hc[Oe]	Hk[Oe]	比抵抗 (μΩcm)
比較例		0 (0)	73.67	18.61	7.62	1.8	0.8	13	12
実施例	1	0.08(0.016)	74.21	19.91	5.89	1.8	0.9	12	12
	2	0.31(0.062)	74.91	18.71	6.38	1.6	0.9	13	14
	3	0.82(0.164)	74.29	18.92	6.80	1.6	0.6	14	14
	4	3.32(0.664)	75.23	19.26	5.52	1.5	0.8	14	14
	5	8.29(1.658)	75.40	18.94	5.66	1.5	1.1	14	14
	6	23.4(4.68)	75.17	18.56	6.27	1.5	0.8	14	15

括弧内は、めっき浴中のSiO₂の濃度

[0048]under [from Table 2] a plating bath -- silica -- by adding sol, he can understand that the specific resistance of a plating film goes up notably. the silica under plating bath from a viewpoint of raising the specific resistance of a plating film -- sol -- it can be said that more ones of quantity are good.

[0049]however, the silica under [an experiment to] plating bath -- when the quantity of sol increased, it also turned out that saturation magnetic flux density decreases in monotone. Therefore, the optimum amount of the silicic acid anhydride under plating bath is 23g/l. from 0.31.

[0050]silica -- alumina sol was blended instead of sol and same measurement was performed. The result seemed to be Table 3.

[0051]

[Table 3]

めっき浴中のアルミナゾル濃度と磁性薄膜の特性

	No	浴アルミナゾル濃度 (g/リットル)	磁性膜組成[wt%] Co	Ni	Fe	磁気特性 Bs[T]	Hc[Oe]	Hk[Oe]	比抵抗 (μΩcm)
比較例		0	73.67	18.61	7.62	1.8	0.8	13	12
実施例	1	0.05(0.01)	74.07	18.13	7.80	1.7	1.2	13	13
	2	0.3 (0.06)	74.47	17.99	7.53	1.7	0.9	13	13
	3	0.8 (0.16)	74.57	17.98	7.45	1.6	0.9	13	14
	4	3.3 (0.66)	74.44	19.07	6.49	1.4	1.4	12	15
	5	8.3 (1.66)	74.38	18.75	6.87	1.4	1.3	12	19
	6	23.3(4.66)	74.20	18.70	7.10	1.4	1.2	12	17

括弧内は、めっき浴中のAl_2O_3の濃度

[0052]the case where alumina sol is used -- silica -- when the specific resistance of the plating film went up notably and the quantity of the alumina sol under plating bath increased by seeing the same tendency as the case where sol is added during a bath, and adding alumina sol during a plating bath, it turned out that saturation magnetic flux density decreases in monotone.
[0053]Therefore, the optimum amount of alumina under plating bath is 8.3g/l. from 0.8.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a mimetic diagram explaining the structure of the magnetic thin film of this invention.
[Drawing 2]It is an outline perspective view of the thin film magnetic head manufactured by this invention.
[Drawing 3]It is drawing of longitudinal section of the thin film magnetic head of drawing 2.
[Drawing 4]It is an explanatory view showing distribution of the saturation magnetic flux density in a Co-nickel-Fe3 element-system alloy.
[0057]
[Description of Notations]
1 Magnetic thin film
2 Co-nickel-Fe3 element-system alloy
3 Silica or alumina
10 Thin film magnetic head
11 Substrate (treatment object)
15 Lower magnetic thin film
16 Top magnetic thin film

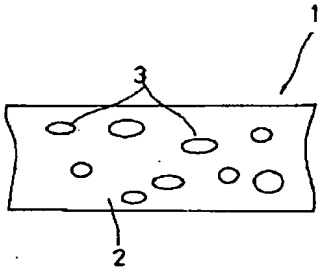
[Translation done.]

* NOTICES *

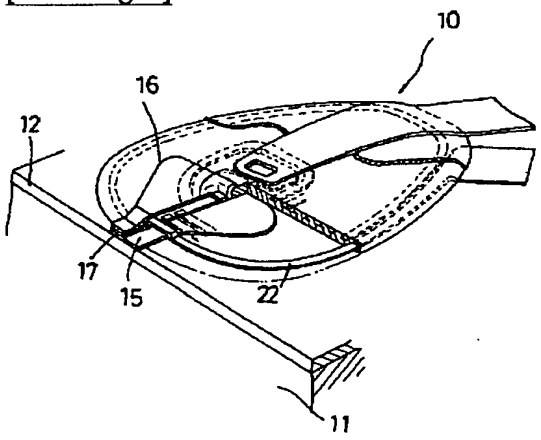
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

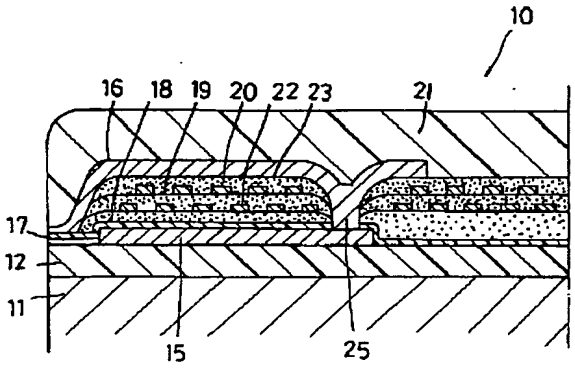
[Drawing 1]



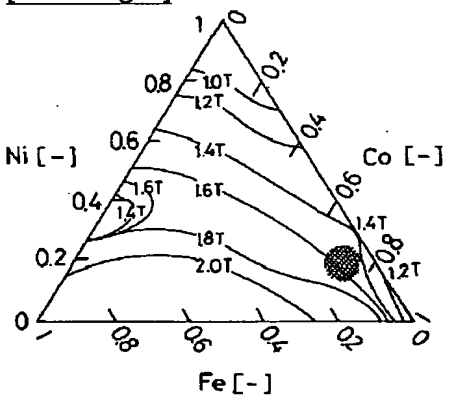
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]